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Electrical properties of ZnO:Sc films deposited by RF magnetron sputtering

Petr Novák[1], Marie Netrvalová[1], Lucie Prušáková[1], Jan Říha[1], Pavol Šutta[1]

[1]University of West Bohemia, Plzeň, Czech Republic

petrnov@ntc.zcu.cz

Zinc oxide (ZnO) is an II-VI wide gap semiconductor used in many industrial applications. Especially, aluminium or gallium doped ZnO films have increasingly attracted attention in recent years as a transparent conducting oxide (TCO) that could potentially replace indium tin oxide. Sputter deposition is attractive method for the formation of TCO thin films for use in solar cells due to the high deposition rates and uniform coverage over large areas. Previous studies have suggested that TCO films prepared by magnetron sputtering exhibit inhomogeneities of the conductivity. Increasing film resistivity at location opposite to the erosion area of the target is mainly attributed to the impact of high energy negative oxygen ions.
In this study we focused on the spatial distribution of the structure and electrical properties of Scandium doped ZnO films (ZnO:Sc). The use of scandium as dopant of ZnO could be interesting due the fact that the ion radius of Sc^{3+} is very close to that Zn^{2+}. ZnO:Sc films were prepared by 13.56 MHz radio frequency (rf) magnetron sputtering using BOC Edwards TF 600 coating system. The films were sputtered in Argon atmosphere from a sintered ceramic target with mixture of 98 wt% ZnO and 2wt% Sc_2O_3. The structure of the films was studied by X-ray diffraction (XRD) using an automatic Panalytical X-ray powder diffractometer X´Pert Pro. Copper Kα radiation (λ = 0.154 nm) was used. The resistivity of the films was measured by the four point probe technique.
It was found that spatial distribution of electrical properties corresponds well with film structure. As the distance between erosion area increases, resistivity decreases due to enhanced crystallinity and lower strain. Also it was found that resistivity of ZnO:Sc films gradually decreased with increasing RF power. Films deposited at RF power 340W outside the influence of the erosive area exhibit lowest resistivity $4\times10^{-3}\Omega$cm.

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